STRIPED BASS: The vision for striped bass is to restore populations to levels of abundance consistent with the Fish and Game Commission striped bass policy. This will support a sport fishery in the Bay, Delta, and tributary rivers and reduce the conflict between protection of striped bass and other beneficial uses of water in the Bay-Delta. Striped bass spawning in the Sacramento River is controlled by water temperatures. Fertilized striped bass eggs require sufficient stream flows and velocities to maintain the eggs in suspension. Striped bass will benefit from management of streamflow, water velocities, and water temperatures. The vision is that restoration of ecological processes and habitats, along with a reduction of stressors, will contribute to a stable and larger striped bass population.

Most of the broader restoration actions for striped bass are centered in the Delta. However, the Sacramento River near Colusa is the primary spawning area for adult striped bass. A water temperature of 61°F is required to trigger striped bass spawning in the spring. Therefore, in some years it may be possible to manipulate water temperatures to reach the threshold for spawning.

AMERICAN SHAD: The vision for American shad is to maintain an naturally spawning population, consistent with restoring native species, that supports a sport fishery similar to the fishery that existed in the 1960s and 1970s. Improvements in late-winter and spring streamflows and stream meander corridors will benefit American shad spawning and rearing in the Sacramento River. The vision is that restoration of ecological processes and habitats, along with a reduction of stressors, will contribute to a stable and larger American shad population.

Although American shad is an introduced species, it supports a highly seasonal and popular sport fishery in the Sacramento, Feather, Yuba, and American Rivers. This species will benefit from actions implemented to restore and maintain ecological processes related to streamflow, floodplain processes, and improved nearshore habitat and cover provided by shaded riverine aquatic and woody debris. These actions are being developed throughout the Central Valley and will provide benefits to numerous species and species communities.

WESTERN YELLOW-BILLED CUCKOO: The vision for the yellow-billed cuckoo is to contribute to the recovery of this State-listed endangered species. The yellow-billed cuckoo along the Sacramento River above the Delta is not a species for which specific restoration projects are proposed. Potential habitat for the cuckoo will be expanded by improvements in riparian habitat areas. These improvements will result from efforts to protect, maintain, and restore riparian and riverine aquatic habitats throughout the Sacramento River Ecological Management Zone, thus sustaining the river meander belt, and increasing the coarse sediment supply to support meander and riparian regeneration.

Yellow-billed cuckoos inhabit extensive deciduous riparian thickets or forests with dense, low-level or understory foliage that abuts rivers, backwaters, or seeps. This species is found in the American River Basin, Colusa Basin, Sutter Basin, Butte Basin, and North Sacramento Valley Ecological Management Zones. Overall, the decline of the cuckoo has resulted from the loss of dense riparian habitat along the lower floodplains of larger streams, including those found within the Sacramento-San Joaquin Delta. Conversion of land to agriculture, urbanization, and flood control projects have caused the loss of habitat.

The yellow-billed cuckoo is listed as endangered by the State of California. This listing charges the state with the responsibility to conserve, protect, restore, and enhance the species as well as to acquire lands for its habitat.

Rebuilding the yellow-billed cuckoo population to a healthy state will require a coordinated approach to restoring ecosystem processes and functions, restoring habitat, and reducing or eliminating stressors. Within the broad context of ecosystem restoration, restoration of the cuckoo populations will include a wide variety of efforts, many of which are being implemented for other ecological purposes or which are nonspecific to the cuckoo. For example, restoration of riparian woodlands along the Sacramento River will focus on natural stream meander, flow, and natural revegetational/successional process. These will be extremely important to providing shaded riverine aquatic habitat, woody debris, and other habitat values that contribute to the health of yellow-billed cuckoo populations.

BANK SWALLOW: The vision for the bank swallow is to contribute to the recovery of this State-

listed threatened species. Potential habitat for bank swallows will be improved by sustaining the river meander belt and increasing the coarse sediment supply to support meander and natural sediment erosion and deposition processes.

NEOTROPICAL MIGRATORY BIRDS: The vision for neotropical migratory birds is to maintain their diversity and abundance by restoring habitat upon which they depend. Protecting and restoring riparian and riverine aquatic habitats will be critical to maintaining population abundance and distribution. The creation of wide riparian corridors or patches will help reduce brown-headed cowbird predation.

VALLEY ELDERBERRY LONGHORN BEETLE: The vision for the valley elderberry longhorn beetle is to recover this federally listed threatened species by increasing its populations and abundance through restoration of riparian systems.

PLANT SPECIES AND COMMUNITIES: The vision for plan species and communities is to protect and restore these resources in conjunction with efforts to protect and restore wetland and riparian and riverine aquatic habitats.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Attaining the vision for the Sacramento River Ecological Management Zone requires near-term funding and implementing actions to achieve the targets. This includes managing water project operations, purchasing title or easements of land from willing sellers, cooperatively developing and implementing a phased fish screening program, acquiring and placing gravel, and performing engineering studies to improve fish passage at diversions and dams. Significant areas of the Sacramento River between Red Bluff and Colusa actively meander. Management actions should aim to protect this functioning process where it is intact, in addition to restoring channel migration within the meander belt.

Several major restoration efforts are either being developed or implemented by state and federal agencies. They will greatly contribute to the success of effort to restore ecological health to the Sacramento River.

CENTRAL VALLEY PROJECT IMPROVEMENT ACT

The U.S. Fish and Wildlife Service (USFWS) and the Bureau of Reclamation (Reclamation) are implementing the Central Valley Project Improvement Act (CVPIA), which provides for restoration of habitats and species and elimination of many stressors. Key elements of the CVPIA program include the Anadromous Fish Restoration Program (USFWS 1997) and the Anadromous Fish Screening Program. Other elements are directed at spawning gravel replenishment, fish passage, water temperature control in the reach between Keswick Dam and RBDD, water acquisition, and other measures that will contribute to health of the Sacramento River and Sacramento-San Joaquin Delta Ecological Management Zones.

The vision for the Sacramento River Ecological Management Zone will contribute to and benefit from the Anadromous Fish Restoration Program, which strives to double the natural production of anadromous fish in the system over the average production from 1967 through 1991.

In addition to the Anadromous Fish Restoration and Anadromous Fish Screening programs, the CVPIA requires the Secretary of the Interior to implement a wide variety of Central Valley Project (CVP) operation modifications and structural repairs in the Central Valley for the benefit of the anadromous fish resources. Sections 3406(b)(1) through (21) of the CVPIA authorize and direct the Secretary, in consultation with other state and federal agencies, Indian tribes, and affected interests to take the following actions, all of which will ultimately assist in protecting and restoring a wide variety of fish and wildlife resources, habitats, and ecological function associated with the Sacramento and other rivers in the Central Valley.

- Modify CVP operations to protect and restore natural channel and riparian values
- Modify CVP operation based on recommendations of the USFWS after consultation with the CDFG.
- Manage 800,000 acre-feet of CVP yield for fish, wildlife, and habitat restoration purposes after consultation with USBR and CDWR and in cooperation with the CDFG.

- Acquire water to supplement the quantity of water dedicated for fish and wildlife water needs including modifications of CVP operations; water banking; conservation; transfers; conjunctive use; and temporary and permanent land fallowing, including purchase, lease, and option of water, water rights, and associated agricultural land.
- Mitigate for Tracy Pumping Plant operations.
- Mitigate for Contra Costa Pumping Plant operations.
- Install temperature control device at Shasta Dam.
- Meet flow standards that apply to CVP.
- Use pulse flows to increase migratory fish survival.
- Eliminate fish losses due to flow fluctuations of the CVP.
- Minimize fish passage problems at Red Bluff Diversion Dam.
- Implement Coleman National Fish Hatchery Plan and modify Keswick Dam Fish Trap.
- Provide increased flows and improve fish passage and restore habitat in Clear Creek.
- Replenish spawning gravel and restore riparian habitat below Shasta Reservoir.
- Install new control structures at the Delta Cross Channel and Georgiana Slough.
- Construct, in cooperation with the State and in consultation with local interests, a seasonally operated barrier at the head of Old River.
- In cooperation with independent entities and the State, monitor fish and wildlife resources in the Central Valley.
- Resolve fish passage and stranding problems at Anderson-Cottonwood Irrigation District Diversion Dam.
- Reevaluate carryover storage criteria for reservoirs on the Sacramento and Trinity rivers
- Participate with the State and other federal agencies in the implementation of the on-going program to mitigate for the Glenn-Colusa Irrigation District's Hamilton City Pumping Plant.
- Assist the State in efforts to avoid losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions.

In addition to the aforementioned CVPIA actions, Section 3406(e)(1 through 6) directs the Secretary to investigate and provide recommendations on the feasibility, cost, and desirability of implementing the actions listed below. When completed, these actions will provide additional understanding of the overall ecosystem problems and provide additional measures which will benefit anadromous fish.

- Measures to maintain suitable temperatures for anadromous fish survival by controlling or relocating the discharge of irrigation return flows and sewage effluent, and by restoring riparian forests.
- Opportunities for additional hatchery production to mitigate the impacts of water development and operations on, or enhance efforts to increase Central Valley fisheries: provided, that additional hatchery production shall only be used to supplement or to re-establish natural production while avoiding adverse effects on remaining wild stocks.
- Measures to eliminate barriers to upstream and downstream migration of salmonids.
- Installation and operation of temperature control devices at Trinity Dam and Reservoir.
- Measures to assist in the successful migration of anadromous fish at the Delta Cross Channel and Georgiana Slough.
- Other measures to protect, restore, and enhance natural production of salmon and steelhead in tributary streams of the Sacramento River.

Section 3406(g) of the CVPIA directs the Secretary to develop models and data to evaluate the ecological and hydrologic effects of existing and alternate operations of public and private water facilities and systems to improve scientific understanding and enable the Secretary to fulfill requirements of the CVPIA.

Upper Sacramento River Fisheries and Riparian Habitat Advisory Council

Established in 1986 by Senate Bill 1086, this council has develop a restoration plan and undertaken efforts to eliminate structural problems related to fish passage and entrainment (Resources Agency 1989). The present focus of the Council is to develop and implement a program to protect and preserve the stream meander corridor and establish a riparian conservation area from Keswick Dam to Verona.

The vision for this important Ecological Management Zone will assist the Upper Sacramento River Advisory Council's Riparian Habitat Committee (SB_ 1086 committee) as it progresses with its plan to restore a naturally sustained riparian corridor, including a designated meander belt and extensive forests, between Keswick Dam and Verona.

Sacramento and San Joaquin Basins Comprehensive Study

As a result of State and Federal legislation, the U.S. Army Corps of Engineers and The Reclamation Board of California are conducting the Sacramento and San Joaquin River Basins Comprehensive Study. The Study will identify and evaluate measures to correct system deficiencies and will formulate a Master Strategy for Flood Damage Reduction and Environmental Restoration. This Master Strategy will identify immediate and staged implementation objectives for resolving flooding and interrelated ecosystem problems in the two basins. A cornerstone of this study is a system-wide evaluation to determine the existing capabilities of the flood management systems with an assessment of ecosystem functions intricately linked with the flood conveyance functions of the river systems.

Endangered Species Recovery Plan Implementation

The ERPP will be an important, if not major, component in the successful implementation of recovery measures for species listed under either the State or Federal ESAs. For example, many of the targets and programmatic actions listed later in this section are derived from existing recovery plan. Two plans that have had major influences on the development of programmatic actions include the Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes (U.S. Fish and Wildlife Service 1996) and the NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon (National Marine Fisheries Service 1997).

Because the ERPP addresses endangered species from a broader ecosystem perspective, many restoration actions will benefit broad species communities and the habitats upon which they depend. These include actions to benefit aquatic and terrestrial fish and wildlife species as well as special plants and plant communities.

State and federal agencies responsible for flood control and natural river resources should collaborate with local jurisdictions, landowners, and river conservation organizations to seek systemize solutions, particularly those that emphasize non-structural solutions to flood control and floodplain protection and restoration. In particular, the U.S. Army Corps of Engineers (Corps) should develop a physical model of the river system and its floodplain (similar to the Butte Basin study, but on a larger scale) to test hypotheses for complex rerouting, detention, and bypassing of floodwater. A Sacramento Valley hydraulic and sediment transport model will be integrated with an evaluation of ecological functions dependent on these physical processes and on the interaction of elements of the ecosystem recovery and land use with floodway capacity.

Completion of studies and subsequent implementation of the U.S. Environmental Protection Agency (EPA) remedies for the IMM Superfund site are needed to attain the safe metal concentrations identified in the basin plan. Pollution control remedies are required at the IMM portal for discharges of remaining sulfide ore deposits inside the mountain, the discharges from tailing piles, and the metal sludge in Keswick Reservoir.

In reaching the vision for this Ecological Management Zone, many cooperative programs need to be developed with federal, state, and local agencies, as well as local interests, such as watershed groups and individual landowners. The cooperative approach also applies to efforts to redirect some industries, such as the aggregate resource industry, to areas outside the active stream channel. These efforts

require support from the industry and counties to undertake new programs.

CALFED BAY-DELTA PROGRAM

CALFED has funded nearly 20 ecosystem restoration projects along the Sacramento River. Most projects screen diversions for irrigated agriculture. Four projects acquire and restore riparian habitat, in conjunction with the SB1086 program. Three projects plan, design, and will construct a new fish ladder at the Anderson-Cottonwood diversion to improve access for winter-run chinook salmon to spawning habitat upstream of the dam.

LINKAGE TO OTHER ECOLOGICAL MANAGEMENT ZONES

The Sacramento River Ecological Management Zone is dependent on virtually all of its adjacent Ecological Management Zones, which cumulatively contribute to the maintenance of important ecological processes and functions, particularly water, sediments, and nutrients. However, many large, westside streams no longer provide significant sediment and gravel to the mainstem river because of the placement of large reservoirs or sediment control basins, and instream gravel mining that depletes gravel sources in the channel for downstream transport.

Restoring and maintaining ecological processes and functions in the Sacramento River Ecological Management Zone are highly dependent on actions and conditions in adjacent zones. For example, maintaining the riparian forests and stream meander quality of the Sacramento River above Chico Landing is dependent on input of largely unregulated flow and sediments from Cottonwood Creek and several undammed tributaries draining Mount Lassen and the northern Sierra Nevada. Therefore, restoring and maintaining important ecological processes in Cottonwood Creek and other nonregulated tributaries is absolutely essential to maintaining the ecosystem health of the Sacramento River.

Cottonwood Creek is the most important watershed component in the upper river downstream of Shasta Reservoir and controls and supports the maintenance of ecological processes and functions in the upper Sacramento River. The Cottonwood Creek Ecological Management Zone is discussed separately, but its importance to the ecological health of the upper Sacramento River is emphasized here, because it is the largest remaining undammed tributary with natural hydrologic conditions and sediment characteristics. In the winter 1986 flood, more than half the flow (and presumably gravel and sediment) in the Sacramento River originated in Cottonwood Creek, greater than the volume represented by all other north-valley streams combined.

Likewise, some fish species depend exclusively on the Sacramento River for migration, spawning, and nursery habitat, while some species that use other Ecological Management Zones for spawning use the Sacramento River as primary migration, nursery, and emigration habitat. Other important Ecological Management Zones dependent on the resources of the Sacramento River include the Sacramento-San Joaquin Delta Ecological Management Zone and the Suisun Marsh/San Francisco Bay Ecological Management Zone. These zones, in turn, provide essential foodweb prey species and critical rearing habitat for outmigrating anadromous fish that spawn in the Sacramento River and its major tributaries.

Additionally, stressors important to fish and wildlife species using the Sacramento River during at least part of their life cycle occur outside the identified Ecological Management Zones. For example, ocean recreational and commercial salmon fisheries remove a large portion of the potential spawning adults from the population each year. New harvest management strategies for the ocean fisheries will be needed to augment improvement to inland ecological processes and functions that maintain key habitats for salmon. Water quality of agricultural tailwater throughout the Colusa Basin that reenters the Sacramento River at Knights Landing or Prospect Slough (Yolo Bypass) affects the health and survival of juvenile fish and prey species in the river, depending on the temperature, toxicity level, dilution ratios, and contaminant concentrations and presence of loadings.

RESTORATION TARGETS AND PROGRAMMATIC ACTIONS

ECOLOGICAL PROCESSES

CENTRAL VALLEY STREAMFLOWS

TARGET 1: More closely emulate the seasonal streamflow patterns in dry and normal year- types by

allowing a late-winter or early-spring flow event of approximately 8,000 to 10,000 cfs in dry years and 15,000 to 20,000 cfs in below normal water-years to occur below Keswick Dam (◆◆).

PROGRAMMATIC ACTION 1A: Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur. Flow events would be provided only when sufficient inflow to Lake Shasta is available to sustain the prescribed releases. This action can be refined by evaluating its indirect costs and the overall effectiveness of achieving objectives.

TARGET 2: Maintain base flows of 6,000 to 8,000 cfs during fall (◆).

PROGRAMMATIC ACTION 2A: Provide flow releases from Shasta Lake and Keswick Dam when necessary to provide the target base flows. Releases would be made only when inflows equal or exceed prescribed releases.

RATIONALE: *The proposed March supplemental flows were selected as a representative value for impact analysis in the Programmatic EIS/EIR. Throughout the ERP, the need to determine optimal streamflow for ecological processes, habitats, and species is repeated. The issues of supplemental flows are complex in term of ecosystem improvements. The frequency, magnitude, duration, timing and rate of change of streamflows that form channels, create and maintain riparian habitat (including all species of vegetation), and promote all life stages of the various aquatic species dependent on a particular stream will never occur within a single year. An optimal flow regime will have to vary, perhaps significantly, from year to year. The supplemental flow recommendations will be an intensive exercise in adaptive management and must be based on credible scientific underpinnings.*

Increasing releases from Shasta Reservoir are the only means of maintaining base flows in the upper river. Late-winter or early-spring flow events of sufficient magnitude attract and sustain adult salmon, steelhead, sturgeon, and American shad; improve transport of juvenile fish downstream; sustain riparian habitat; and sustain gravel recruitment, transport, and cleansing processes. The target flows are consistent with historic and unimpaired flows for the Sacramento River in dry and normal years. These flows may not occur in some years under the present level of project development and operation. Implementing the target level of the flow event must necessarily be on a conservative basis because of the potential cost to water supply. The fall flow pattern needs to be carefully evaluated to ensure protection for incubating chinook salmon eggs. The chinook salmon that spawn in the fall have eggs in the river that incubate into the winter season. Incubating eggs can be severely damaged when wintertime releases from Keswick Dam are dropped below the fall release levels. Other concerns include maintaining high base flows during the fall would cause temperature control problems in the following year under conditions of low carryover storage in Shasta Reservoir or low inter inflow conditions. The fall flow needs to consider the need for carryover storage to provide temperature control in the following year.

If a flow event of equal or greater magnitude has not occurred between Keswick Dam and Red Bluff by March, then supplementing base flows or augmenting small natural releases or reservoir spills with additional reservoir releases is the only means to provide flow events. Such releases would be used only if there is an equivalent or greater inflow to Lake Shasta. March is the logical month to provide such flows, because it is the month when "natural" flow events occurred historically in dry and below normal years, and because opportunities for such flow to occur "naturally" as a function of normal project operation would have been exhausted by then. Water forecasts of the water-year type (critically dry, dry, below normal, above normal, or wet) are available by February and March. The flow event in March would be expected to proceed unimpaired downstream to the Delta, because few or no diversions from the Sacramento River occur during March. (Note that additional flow events are prescribed for the Feather River in March, which will further enhance Sacramento River flows below its confluence with the Feather River.) A March flow event could also help satisfy Delta outflow requirements.

Maintaining natural base flows will help promote natural channel forming, riparian vegetation, and foodweb functions. Base flows also serve to attract steelhead and fall-run and late-fall-run chinook salmon. Unimpaired base flows in fall are approximately 4,000 cfs to 6,000 cfs in dry years, and up to 8,000 cfs in wetter years. Natural base flows

are prescribed only for fall, because, under present project operation, flows in excess of 10,000 cfs are maintained in summer for irrigation and to lower water temperatures for winter-run salmon.

COARSE SEDIMENT SUPPLY

TARGET 1: Increase gravel recruitment in the upper Sacramento River between Keswick Dam and the RBDD by 10,000 to 20,000 cubic yards annually to provide adequate spawning habitat for targeted levels of salmon and steelhead and to sustain stream meander processes below Red Bluff. (This is the estimated amount of spawning-sized gravel captured annually by Shasta Dam.) (◆◆)

PROGRAMMATIC ACTION 1A: Develop a cooperative program to stockpile gravel at strategic locations along the Sacramento River below Keswick Dam where riverflow will move gravel into the river channel to mimic natural gravel recruitment into the upper river. Determine the adequacy of this action and adjust amount and locations as necessary.

PROGRAMMATIC ACTION 1B: Develop a cooperative program to reactivate gravel recruitment to the river by exposing existing sources of river gravel on islands, bars, and banks that have become armored to riverflows. This action should be implemented on a conservative basis, because the availability of such inchannel gravel, costs of activating the gravel, indirect impacts, and potential effectiveness have not been determined.

RATIONALE: *Replenishing gravel supplies to a level sufficient to support target populations of salmon and steelhead will help to improve populations to desirable levels and to maintain such levels once achieved. Replenishing gravels to maintain channel-forming processes and stream meanders in the upper Sacramento River will help to maintain fish and wildlife habitats, aquatic algae and invertebrate production, and streamside vegetation (California Department of Water Resources 1980). A predevelopment level of gravel recruitment should be adequate to restore the natural ecological processes supported by gravel recruitment, but may require experimenting, monitoring, and experience to determine the exact amount of gravel supplies necessary to meet the objective. Implementation of gravel supplementation projects above RBDD will be subject to adaptive management, with elements that include focused research on sediment transport processes, and monitoring of gravel quality and quantity. Sediment supplementation programs need to be integrated with downstream channel forming processes, which will be subject to adaptive management, as well as to a different set of indicators, monitoring, and focused research.*

On the river side of natural levees in alluvial valleys, fluvial processes typically create dynamic river meander patterns, including oxbow lakes from bend cutoffs, secondary channels that carry flow only during high stage, and nonvegetated point bars where new deposits of sand and gravel collect in low-energy zones of inside bends and bendway crossovers (riffles). In cross section, natural alluvial streams are typically terraced and asymmetrical, with steep banks on eroding outside bends, low-angle banks on inside bends, and several nearly horizontal surfaces corresponding to river floodplain elevations of various magnitude and frequency. If a river has incised (i.e., eroded down below the original channelbed surface) as a result of natural or human-induced factors, the abandoned upper floodplain may become a "terrace" (former floodplain) where riparian forest may then convert to valley oak woodlands or grassland-oak savannah.

The characteristic three-dimensional shape of a river described above (its "fluvial geomorphology" or landforms created by flowing water) is indicative of a river that is in dynamic balance with the interaction of its flood regime, sediment supply, vegetation patterns, climate, and valley slope. Rivers with a natural shape and hydrologic condition generally support the most diverse mixture of habitats and fish and wildlife species and are the most resilient to natural or human disturbance.

STREAM MEANDER

TARGET 1: Preserve and improve the existing stream meander belt in the Sacramento River between Red Bluff and Chico Landing by purchase in fee or through easements of 8,000 to 12,000 acres of riparian lands in the meander zone (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to evaluate the feasibility of removing riprap from banks to the extent possible, consistent with flood management requirements, and reduce effects of other structures, such as bridges, to provide a sustainable meander corridor.

PROGRAMMATIC ACTION 1B: Purchase easements to offset losses to property owners for land lost to meander process.

TARGET 2: Preserve and improve the existing stream meander belt in the Sacramento River between Chico Landing and Colusa by purchase in fee or through easements of 8,000 to 12,000 acres of riparian lands in the meander zone (◆◆◆).

PROGRAMMATIC ACTION 2A: Develop a cooperative program to evaluate the feasibility of removing riprap from banks to the extent possible, consistent with flood control management, and reduce effects of other structures, such as bridges, to provide a sustainable meander corridor.

PROGRAMMATIC ACTION 2B: Purchase easements to offset losses to property owners for land lost to meander process.

RATIONALE: *Preserving and improving the stream meander belt below Red Bluff will ensure that this important natural process is maintained in the Sacramento River. This reach is important for spawning and rearing salmon and steelhead. A natural meander process will provide near-optimal habitat for spawning (through gravel recruitment), rearing (channel configuration, cover, and foodweb), and migration. There is limited potential natural channel above Red Bluff. Below Chico Landing, flood control levees limit the potential of restoring the natural meander of that reach. Overall, the program must be consistent with flood control requirements and in the longer-term, should reduce need for future flood control efforts by using natural system resilience and flood control characteristics.*

During the selection -process and during implementation, additional benefits will accrue by looking for land within or adjacent to the meander belt which support special status species and to include these areas whenever available in the acquisition. Some the species to be considered include the valley elderberry longhorn beetle, bank swallow, western yellow-billed cuckoo, and giant garter snake.

NATURAL FLOODPLAIN AND FLOOD PROCESSES

TARGET 1: Increase and maintain floodplains in conjunction with stream meander corridor restoration (◆◆).

PROGRAMMATIC ACTION 1A: Develop and implement a cooperative program, consistent with flood control requirements, to evaluate the feasibility of altering river channel configurations in leveed reaches of the Sacramento River to increase the areal extent of floodplains inundated during high flow periods.

RATIONALE: *Floodplain inundation is the seasonal flooding of floodplain habitats, including riparian and riverine aquatic habitats. Flooding of these lands provides important seasonal habitat for fish and wildlife and provides sediment and nutrients to both the flooded lands and aquatic habitats that receive the returning or abating floodwater. The flooding also shapes the plant and animal communities in the riparian, wetland, and upland areas subject to flooding. Floodplain flooding is a secondary ecosystem process related to water and sediment flow through the Sacramento-San Joaquin basin and their landforms. Opportunities to restore or enhance this process are possible by changing landscape features, landforms, and seasonal distribution of flow volume through the system.*

Channelizing and shortening rivers; removing instream vegetation and gravel; and creating symmetrical, trapezoidal channels sandwiched between narrow, steep-sided levees diminish the natural tendency of alluvial rivers to form characteristic compound dimensions and patterns. A channelized river may be relatively stable if the potential for major flood events has been eliminated, sediment input is minimal, vegetation does not naturally grow along the banks, and the channelbed is incapable of incising. The absence of river floodplains and adequate meander width for bar and riffle formation within levee-confined channels prevents or depresses the formation of natural river morphology that is the structural framework for riverine and estuarine fish and wildlife habitats. Stabilizing artificial banks with rock riprap and clearing vegetation further degrades habitat and diminishes natural channel-forming processes.

An important exception here is the existence of the Sacramento River basin overflow system: the Butte basin and Sutter and Yolo Bypasses. Although considerably smaller than their original extent, these three floodplains move and detain floodwaters in volumes and patterns similar to those of presettlement flow, while reducing the risk of

overtopping levees near populated areas. At flood peak, there is approximately five times more flow in the Sacramento River bypass floodplain system than in the main river channel it drains. However, the floodplain bypass system does not exist in the largest historic flood basin of the Sacramento River, the Colusa basin, which is disconnected by levees from the river. Also, the lowest areas of the Sutter basin are outside of the levees and the Sutter Bypass traverses slightly higher ground on a portion of the historical basin floodplain.

CENTRAL VALLEY STREAM TEMPERATURES

TARGET 1: Maintain mean daily water temperatures at levels suitable for maintaining all life-history stages of chinook salmon and steelhead in the Sacramento River between Keswick Dam and RBDD in above normal and wet years, and between Keswick Dam and RBDD in other year types (◆◆◆).

PROGRAMMATIC ACTION 1A: Cooperatively develop and implement a balanced river regulation program that provides sufficient carryover storage at Shasta Dam to ensure that suitably low water temperatures are reached to protect chinook salmon and steelhead spawning, incubating eggs, and young fish, particularly in consecutive dry and critically dry years.

RATIONALE: *The temperature objective for the upper Sacramento River is less than or equal to 56°F from Keswick Dam to RBDD for operation of CVP in the State Water Resources Control Board's (SWRCB's) Order 90-5. However, these criteria cannot be met consistently, and other structural facilities and operation measures are needed. These facilities and operational measures must be developed and implemented to enable the long-term attainment of the SWRCB-required temperature criteria.*

A temperature control or "shutter device" has been installed to permit the selective withdrawal of water from Shasta Reservoir over a wide range of depths and temperatures. With this device, warm water could be withdrawn from the upper lake levels when needed, while conserving the deeper, cold water for release when it would most benefit chinook salmon. Operation criteria for temperature criteria needs to include temperature requirements of steelhead trout which spawn in the late-winter/early spring. Controlling temperatures solely for chinook salmon would have serious impacts to naturally spawning steelhead. Operating the temperature control device allows Reclamation greater effectiveness and flexibility in temperature control operations while maintaining hydroelectric power generation. The temperature control device also provides a secondary benefit to anadromous fish by controlling turbidity. Because the temperature control device is installed and operational, operations and carryover storage requirements must be reassessed and new criteria established to optimize attainment of water temperature objectives.

In the long term, Sacramento River water temperatures can be moderated by restoring a healthy riparian forest. Implicit in restoring an extensive riparian forest is a need to reconnect the river with its floodplain to promote natural riparian succession.

HABITATS

RIPARIAN AND RIVERINE AQUATIC HABITATS

TARGET 1: Provide conditions for riparian vegetation growth along channelized portions of the Sacramento River (◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to plant vegetation on unvegetated, riprapped banks consistent with flood control requirements. Implementation will occur in phases, results will be monitored and restoration approach will be adjusted as necessary under adaptive management.

PROGRAMMATIC ACTION 1B: Setback levees may be constructed on leveed reaches of the river to provide a wider floodplain and greater development of SRA habitat. Because of the potential indirect impacts on land use and uncertainty of cost and technical feasibility of setback levees, such development will be experimental and conservative, and will depend on adaptive management.

PROGRAMMATIC ACTION 1C: Cooperatively develop and implement a study to determine appropriate conditions for the germination and establishment of riparian woody plants along the river.

TARGET 2: Increase the ecological value of low-to moderate-quality SRA habitat by changing land use and land management practices (◆◆).

PROGRAMMATIC ACTION 2A: Purchase property or easements and allow habitat to improve naturally. Properties to be considered should be developed through a prioritizing process that considers habitat quality and importance, technical feasibility and cost of purchase and improvement, and consent of landowners.

PROGRAMMATIC ACTION 2B: Provide incentives and technical support for private landowners to protect and improve existing SRA habitat.

TARGET 3: Maintain existing streamside riparian vegetation (◆◆◆).

PROGRAMMATIC ACTION 3A: Through purchase, conservation easement, and voluntary participation of landowners, protect SRA habitat from development. Where high-priority properties are already in government ownership or available for purchase or easement, preservation efforts should be undertaken as experiments to develop technical details, cost-effectiveness, and overall approach and consensus for the program. Full implementation of this program would depend on results of experiments and would be subject to adaptive management.

RATIONALE: *Riprapped banks in the leveed section of the river below Chico Landing downstream to Sacramento are the greatest cause of SRA fragmentation. Restoring vegetation will benefit juvenile salmon rearing by providing cover and food, spawning substrate for other fish, such as Sacramento splittail, and refuge for juvenile fish during periods of high water. Improving low- to moderate-quality SRA habitat will benefit juvenile salmon and steelhead by providing improved shade, cover, and food. Wildlife will also benefit from improved habitat. Protecting and improving existing SRA habitat may involve changes in land use. Limited available funds may require that priorities be set, with high-priority, low-cost sites developed initially. For sites where consensus exists, immediate experimental action can be taken. Because of the importance and limited distribution and abundance of SRA habitat, all existing quality habitat should be protected.*

In developing this element of the restoration plan, it is important not to develop just a very long, narrow band of riparian vegetation. Although it needs further development, a "string-of-pearls" approach should be considered. In this concept the long, narrow band of riparian vegetation would be interspersed with larger patches of riparian vegetation. This concept would mesh well with nodes of setback levees to provide a minimal floodplain, seasonal floodplain inundation, and natural or supplemented riparian revegetation.

FRESHWATER FISH HABITAT AND ESSENTIAL FISH HABITAT

TARGET 1: Maintain and improve existing freshwater fish habitat and essential fish habitat through the integration of actions described for ecological processes, habitats, and stressor reduction or elimination (◆◆).

PROGRAMMATIC ACTIONS: No additional programmatic actions are recommended.

RATIONALE: *Freshwater fish habitat and essential fish habitat are evaluated in terms of their quality and quantity. Actions described for ecological processes, stressor reduction, and riparian and riverine aquatic habitat should suffice to maintain and restore freshwater fish habitat and essential fish habitat. For example, maintaining freshwater and essential fish habitats is governed by actions to maintain streamflow, improve coarse sediment supplies, maintain stream meander, maintain or restore connectivity of the Sacramento River and its floodplain, and in maintaining and restoring riparian and riverine aquatic habitats.*

REDUCING OR ELIMINATING STRESSORS

WATER DIVERSIONS

TARGET 1: Reduce entrainment of juvenile salmon, steelhead, sturgeon, and splittail into water diversions to levels that will not impair stock rebuilding or species restoration (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to screen all diversions greater than 250 cfs and one- to two-thirds of all smaller unscreened diversions. This programmatic level of action should be sufficient to provide the data